Investigating Organic Carbon and Fine-grain Sediment Source Dynamics Along Fanno Creek, Oregon

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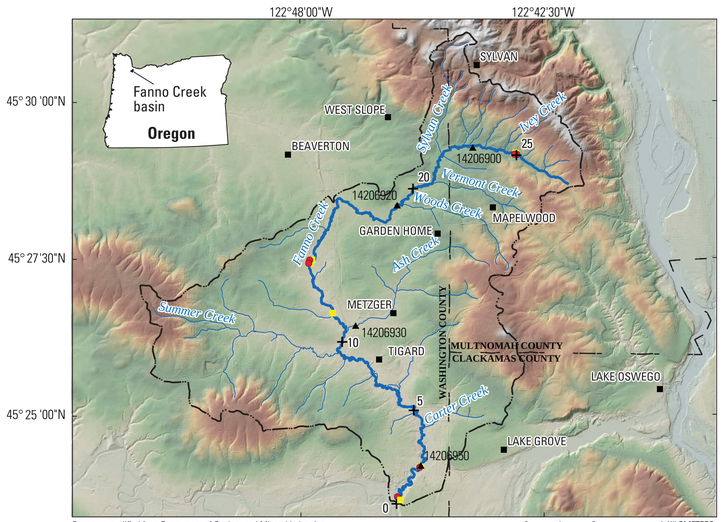
Abstract

In 2010, the U.S. Geological Survey (USGS) began investigating the sources and sinks of organic matter in the highly urbanized watershed of Fanno Creek, a tributary of the Tualatin River, Oregon. Organic matter, more specifically organic carbon, is abundant in Fanno Creek and has been tied to a variety of water-quality concerns, including large algal blooms and periods of low dissolved oxygen concentrations in the Tualatin River. Runoff from impervious surfaces produces flashy streamflow response, which often undercuts stream banks and leads to severe instability along parts of the channel. Since organic carbon is commonly found in the fine-grained, organic-rich bed and bank sediments throughout the watershed, developing a better understanding of sediment transport dynamics should greatly improve the effectiveness of restoration efforts.

Systematic mapping and measurement of sedimentation patterns, volumes, and rates, using a combination of Geographic Information Systems (GIS) and field techniques, are being used to determine the sources and sinks of organic carbon along Fanno Creek. From these methods, the spatial distribution and connectivity of erosion and deposition features (e.g., cutbanks and floodplains) is observed, and localized sediment transport volumes are being quantified. Field mapping, supplemented with remote sensing data, is being used to determine areas of erosion and deposition and whether those processes are related to mass-wasting or fluvial processes. Dendrogeomorphic analysis (i.e., relating tree core data to stream-bank root exposure) is being used to determine minimum rates of erosion at several sites throughout the basin. Erosion and deposition rates for specific storm events at seven focus sites in the basin are being estimated using repeat measurements of erosion pins and deposition plates.

Preliminary results indicate that 1) mass-wasting processes are more prevalent in the basin than fluvially driven processes for eroding and transporting sediment, 2) more dynamic erosion and deposition occurs at stream meander sites than straight-channel sites, 3) sediment sources and sinks are largely determined by local stream geology (e.g., hardpan clay substrate), local bank protection, and floodplain land use/cover, 4) individual storm events dictate the temporal distribution of erosion and deposition, 5) in-stream wood plays a vital role in retaining sediment, organic debris, and trash during the low flow season, and 6) riparian alteration and bioturbation by wildlife (e.g., beaver and nutria) have created areas susceptible to erosion and deposition by both fluvial and mass-wasting processes.

Fanno Creek Basin



Base map modified from Department of Geology and Mineral Industries and U.S. Geological Survey digital data, various scales. UTM Zone 10N, NAD83

Explanation

- River kilometer
- Gaging station
- Erosion pin site
- Deposition plate site
- City

Elevation, in meters above NAVD88: High: 1,075; Low: 0

Fig 1. Map of the Fanno Creek basin, Oregon, with locations of erosion pin and deposition plates.

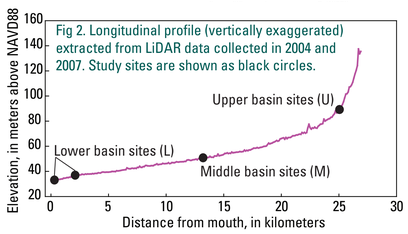


Fig 2. Longitudinal profile (vertically exaggerated) extracted from LiDAR data collected in 2004 and 2007. Study sites are shown as black circles.

Basin characteristics

Drainage area (km²)	82.4
Channel length (km)	27
Mean annual precipitation (cm)	107
Geologic setting	Columbia River and Boring basalts and Willamette Group terrestrial rocks dominate the headwater areas while Quaternary surficial deposits dominate most of the basin
Land use	Urban, 86.8%; Historically forested, now 22.8%
Major tributaries	Sylvan Creek, Vermont Creek, Woods Creek, Ash Creek, Summer Creek

Approach

Sediment sources and sinks were assessed with several techniques:

Erosion Pin Measurements

Repeat Cross Sections

Deposition Plate Measurements

Dendrogeomorphic Measurements

Geomorphic Mapping with Rapid Geomorphic Assessments

Mapping

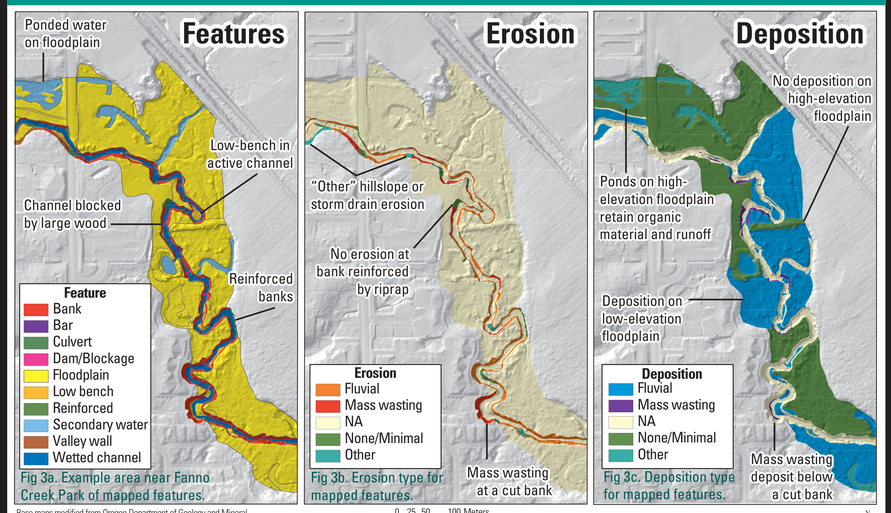


Fig 3a. Example area near Fanno Creek Park of mapped features.

Fig 3b. Erosion type for mapped features.

Fig 3c. Deposition type for mapped features.

Base maps modified from Oregon Department of Geology and Mineral Industries digital data, 1-meter resolution. UTM Zone 10, NAD83

0 25 50 100 Meters
0 125 250 500 Feet
N

Sediment sources and sinks were mapped in the field and with LiDAR and aerial photographs. Approximately 70% of the banks along Fanno Creek are eroding or have a high potential for eroding. In-channel sinks, such as bars, are most abundant in the lower basin and minimal elsewhere except as slumped bank material, at beaver dams, or where other large wood blocks the channel.

Measured Erosion and Deposition

Short term

High flow events (>2-year flow) deposited substantial amounts of sediment on the floodplain and low benches within the active channel; however, greater amounts of sediment can be deposited from moderate but more frequent flows. Measurements from erosion pins showed both erosion and deposition with greater changes following higher flow periods. Deposition on banks measured from the pins was typically the result of mass wasting or soil creep.

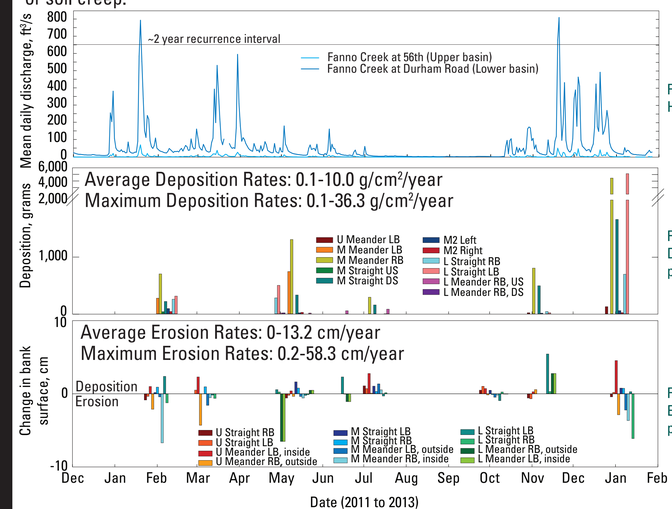
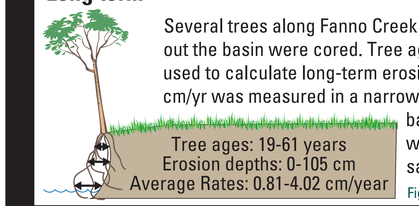


Fig 4a. Hydrograph

Fig 4b. Deposition plates

Fig 4c. Erosion pins

Long term



Several trees along Fanno Creek have been undercut. Twelve trees throughout the basin were cored. Tree age and the degree of undercutting were used to calculate long-term erosion rates. A maximum erosion rate of 5.08 cm/yr was measured in a narrow stretch of the channel with steep, bare banks. There is no apparent trend in rates with tree age or basin position for the small sample size.

Fig 5. Illustration of undercut tree measurements

Acknowledgements

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